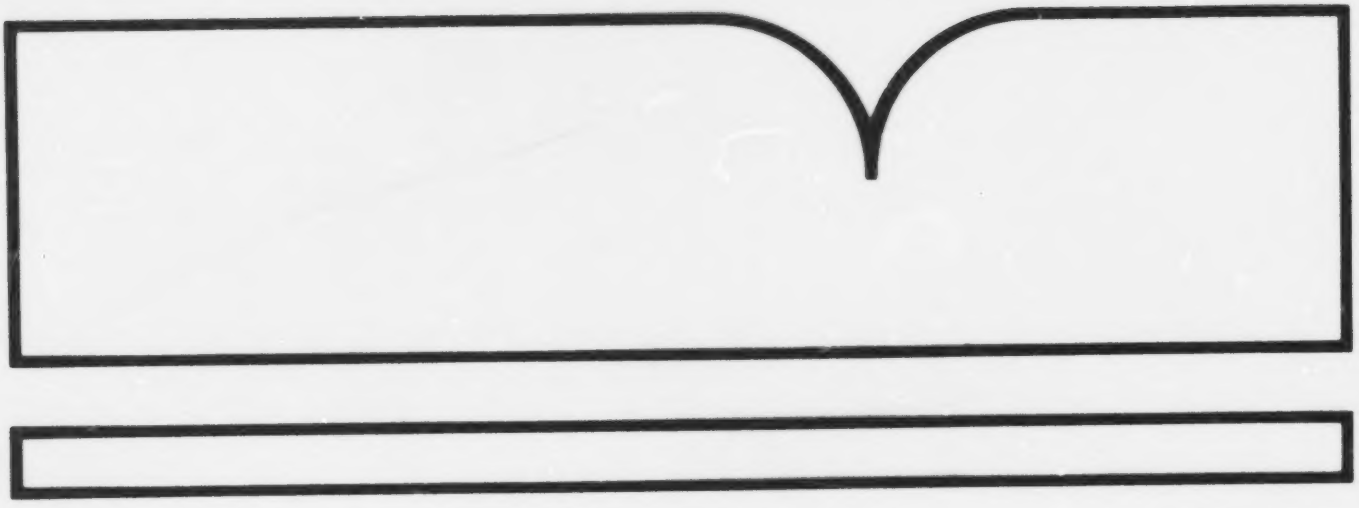
PB88-172135

Superfund Record of Decision (EPA Region 8) Denver Radium Site, 12th and Quivas Properties, Colorado (Selected Remedial Action) September 1987

(U.S.) Environmental Protection Agency
Washington, DC

29 Sep 87



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29 Sep 87

PERFORMER: Environmental Protection Agency, Washington, DC.
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See also PB88-172176, and PB88-126461.Portions of this document are not fully legible.

The decision document presents the selected remedial action for the operable unit of the Denver Radium Site developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Contingency Plan (40 CFR Part 300). The decision is based upon the administrative record for the 12th and Quivas properties, Operable Unit I of the Denver Radium Site. The attached index identifies the items which comprise the administrative record upon which the selection of the remedial action was based.

KEYWORDS: *Industrial wastes, *Hazardous materials, *Waste disposal, *Superfund program, *Remedial actions, *Record of decision.

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PB88-172135

United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R08-87/013
September 1987

EPA

Superfund Record of Decision:

Denver Radium/12th & Quivas,CO

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DECLARATION
FOR THE
RECORD OF DECISION

Site Name

12th and Quivas Properties
Operable Unit I
Denver Radium Site

Site Location

West 12th Avenue and Quivas Street
Denver, Colorado

Statement of Purpose

This decision document presents the selected remedial action for this operable unit of the Denver Radium Site developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Contingency Plan (40 CFR Part 300).

The State of Colorado has concurred on the selected remedy for this operable unit. (See attached letter.)

Statement of Basis

This decision is based upon the administrative record for the 12th and Quivas properties, Operable Unit I of the Denver Radium Site. The attached index identifies the items which comprise the administrative record upon which the selection of the remedial action was based.

Description of the Selected Remedy

This Record of Decision addresses the contamination present on what is known as the 12th and Quivas properties, Operable Unit I of the Denver Radium Site. This is the fourth operable unit of the Denver Radium Site for which EPA has selected a remedy. The EPA is undertaking additional feasibility studies to evaluate remedial action alternatives at the other Denver Radium

Site operable units and will complete a Record of Decision or an Action Memorandum for each of the operable units for which a remedy has not already been selected.

Radium and its associated decay products are the hazardous substances of primary concern that have been released and continue to be released into the environment at the 12th and Quivas properties. Long-term exposure to radium and its decay products has been shown conclusively to increase the risk of contracting lung cancer.

EPA's preferred remedial action alternative for the 12th and Quivas properties is Offsite Permanent Disposal. However, until a facility suitable for permanent disposal of the 12th and Quivas properties material is designated and, if necessary, acquired and developed, this alternative cannot be implemented. Pursuant to CERCLA Section 104(c)(3)(C)(ii), it is the responsibility of the State of Colorado to assure the availability of a facility for offsite disposal of the Denver Radium Site material. Although both the EPA and State of Colorado are continuing to seek a permanent disposal site, the State estimates that this process could take up to five years. Given the length of time which may pass before the State assures the availability of an offsite permanent disposal facility, and in order to prevent or minimize the threat to public health and the environment, the EPA has determined that a remedial action alternative which includes temporary response actions should be implemented at the 12th and Quivas properties.

The selected remedy for the 12th and Quivas properties is Onsite Temporary Containment (Capping), Offsite Permanent Disposal. This remedial action alternative will attain a degree of cleanup of the hazardous substances which will assure both short-term and long-term protection of human health and the environment. The present-worth cost of this alternative is $3,702,800 based upon a ten-percent interest rate, a five-year discount period, and a perpetual monitoring period. This remedy entails:

- placing a cap over the identified open areas of soil contamination;

- excavating the contaminated soil lying under several structures on the properties and placing this material into a temporary storage facility onsite;

- maintaining the cap and temporary storage facility until a facility suitable for the permanent disposal of Denver Radium Site wastes becomes available; and

- final removal of the contaminated material to the permanent disposal facility.

Remedial Design for the 12th and Quivas properties will include the selected remedy described above and EPA's preferred

remedial action alternative, Offsite Permanent Disposal. Should the State of Colorado fulfill its obligation to assure the availability of a suitable disposal facility for material from the Denver Radium Site by the time EPA has concluded Remedial Design for the 12th and Quivas properties, the EPA may immediately implement its preferred alternative, Offsite Permanent Disposal.

Operation and maintenance activities will be required to ensure the effectiveness of the temporary response actions. These activities include site inspections, ongoing radiological monitoring, and possible minor repairs to the cap or temporary storage facility. Also included as an operation and maintenance activity is a review of the properties which, pursuant to SARA Section 121(c), must be conducted no less than every five years if a remedial action is selected that results in any hazardous substances remaining onsite. Since EPA does not anticipate that any hazardous substances will remain onsite longer than five years, the cost of this review is considered a contingency. The maximum total of the discounted annual operation and maintenance costs of these activities using a five-year discount period and a ten-percent discount rate is $290,000. This operation and maintenance cost is included with the present-worth total alternative cost mentioned above.

Declarations

Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Contingency Plan (40 CFR Part 300), I have determined that the selected remedy for the 12th and Quivas properties, Operable Unit I of the Denver Radium Site, is protective of human health and the environment, attains Federal and State public health and environmental requirements that are applicable or relevant and appropriate, and is cost-effective. The remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. Even though the selected remedy does not satisfy the statutory preference for treatment which reduces the toxicity, mobility, and volume of hazardous substances as its principal element, the remedy will address the principal threat at the properties. Treatment was determined to be impracticable based upon effectiveness, technical feasibility, implementability, and cost.

James J. Scherer
Regional Administrator
EPA Region VIII

Sept. 29, 1987
Date

RECORD OF DECISION
SUMMARY

Site Name

12th and Quivas Properties
Operable Unit I
Denver Radium Site

Site History

When radium was discovered in 1898, it was considered to be a wonder drug and was used especially in the treatment of cancer. This caused the demand for radium to escalate, setting in motion the radium boom of the early 1900s. Radium was first found in pitchblende, a rare mineral found in Bohemia, Saxony, Cornwall, and Colorado. Soon after these discoveries, another radium-bearing mineral, carnotite, was discovered in Colorado.

Prior to 1914, radium was not produced in the United States. Rather, radium-bearing ore was shipped from the States to Europe where it was refined. The onset of World War I in Europe caused concern in the United States that radium importation might be blocked. This concern led to the establishment of the National Radium Institute in Denver in 1913. The National Radium Institute successfully demonstrated that radium could be extracted from carnotite. Soon several radium, vanadium, and uranium processors were operating in Denver. The Denver radium, vanadium, and uranium industry thrived until the early 1920s, when extremely rich deposits of ore were discovered in Africa. Most Denver producers could not keep up with their African competitors and were forced out of business.

The Pittsburgh Radium Company, a division of the National Vanadium Products Company, refined ore at 1201 Quivas Street until 1924. This property is currently part of the 12th and Quivas properties, Operable Unit I of the Denver Radium Site. The source of the contamination on the 12th and Quivas properties is believed to be the result of Pittsburgh Radium Company operations.

Response History

In 1979, EPA noted a reference to the National Radium Institute in a 1916 United States Bureau of Mines report. Subsequent field research revealed the presence of thirty-one radioactive sites in the Denver metropolitan area, of which four are now included with the 12th and Quivas properties (Figure 1).

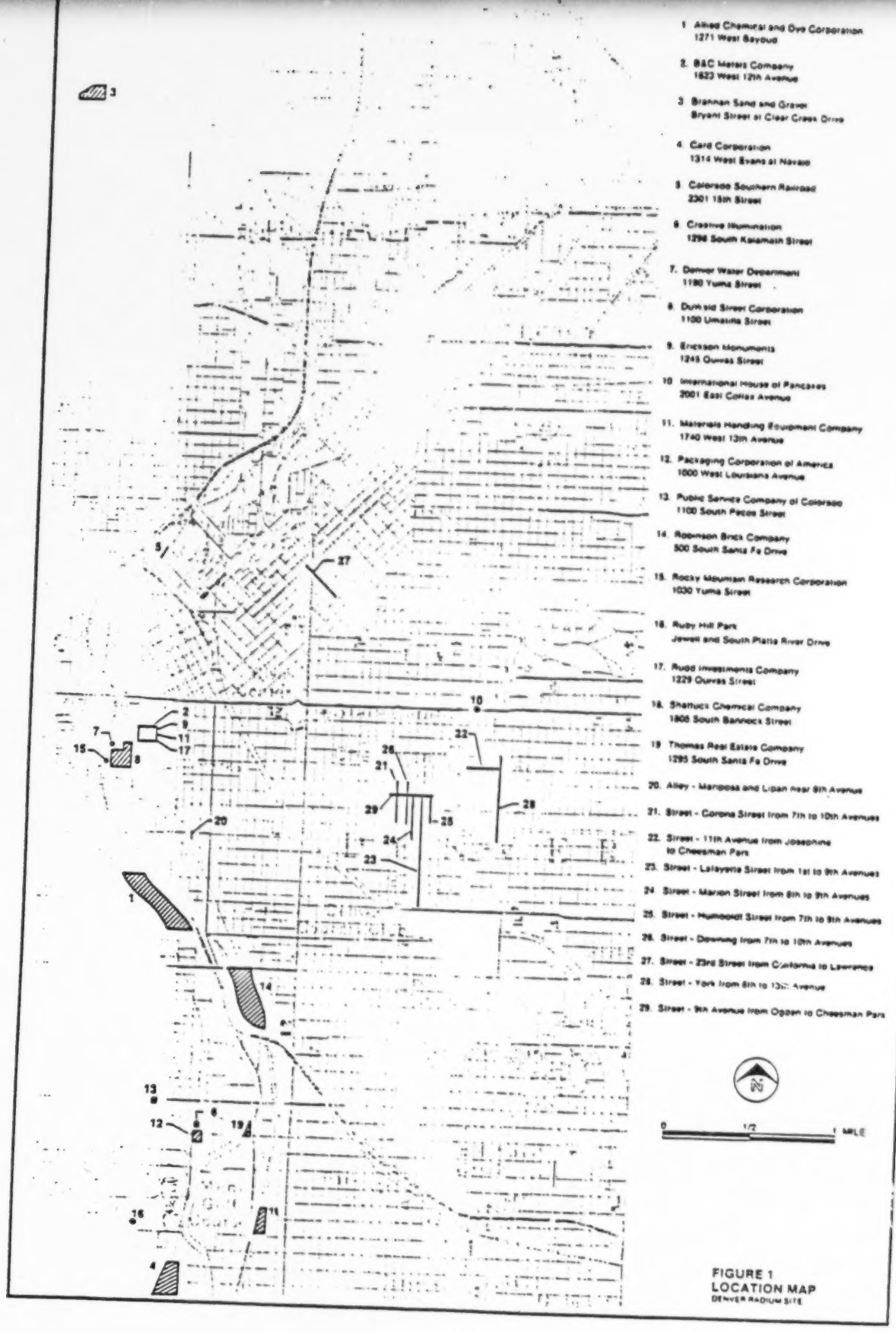
1 Allied Chemical and Dye Corporation
1271 West Bayaud
2. B&C Metals Company
1623 West 12th Avenue
3 Brannan Sand and Gravel
Bryant Street at Clear Creek Drive
4 Card Corporation
1314 West Evans at Navajo
5 Colorado Southern Railroad
2301 15th Street
6 Creative Illumination
1298 South Kalamath Street
7. Denver Water Department
1180 Yuma Street
8 Durbid Street Corporation
1100 Umatilla Street
9. Ericsson Monuments
1245 Ouvas Street
10 International House of Pancakes
2001 East Colfax Avenue
11. Materials Handling Equipment Company
1740 West 13th Avenue
12. Packaging Corporation of America
1000 West Louisiana Avenue
13. Public Service Company of Colorado
1100 South Pecos Street
14. Robinson Brick Company
500 South Santa Fe Drive
15. Rocky Mountain Research Corporation
1030 Yuma Street
16. Ruby Hill Park
Jewell and South Platte River Drive
17. Rudd Investments Company
1229 Ouvas Street
18. Shattuck Chemical Company
1906 South Bannock Street
19 Thomas Real Estate Company
1295 South Santa Fe Drive
20. Alley - Mariposa and Lipan near 8th Avenue
21. Street - Corona Street from 7th to 10th Avenues
22. Street - 11th Avenue from Josephine to Cheesman Park
23. Street - Lafayette Street from 1st to 9th Avenues
24. Street - Marion Street from 8th to 9th Avenues
25. Street - Humboldt Street from 7th to 9th Avenues
26. Street - Downing from 7th to 10th Avenues
27. Street - 23rd Street from Columbine to Lawrence
28. Street - York from 8th to 13th Avenue
29. Street - 9th Avenue from Ogden to Cheesman Park
N
0
1/2
1 MILE

FIGURE 1
LOCATION MAP
DENVER RADIUM SITE

Immediately after identifying these properties, the Radiation Control Division of the Colorado Department of Health officially notified the affected property owners of the presence of radiological contamination on their properties. The letters requested that no excavation or soil movement be undertaken without first contacting the Division.

In August, 1981, the Colorado Department of Health, under a cooperative agreement with EPA, assumed lead activities and initiated engineering assessments of the majority of the original 31 properties. In October, 1981, shortly after the cooperative agreement was awarded to the State, the Denver Radium Site was placed on the Interim Priorities List. The Site was included on the Final National Priorities List promulgated on September 8, 1983.

EPA resumed Fund-lead activities in June, 1983, because the Colorado State Legislature failed to appropriate the state cost share for remedial planning required by EPA at the time. In December, 1983, EPA directed its contractor to conduct a Remedial Investigation (RI) to determine the nature and extent of the contamination present on those properties which the State did not previously study plus several contiguous properties where additional contamination was suspected. EPA also directed its contractor to conduct a Feasibility Study (FS) to evaluate proposed remedies for the contamination present on all of the Denver Radium Site properties which now, with the addition of the contiguous properties, totaled over 40 properties.

Because of the enormity and complexity of the Denver Radium Site, EPA determined that response actions undertaken in operable units would be cost-effective and consistent with a permanent remedy for the entire Denver Radium Site. Thus, the original Denver Radium Site properties plus the several contiguous properties where contamination was discovered subsequent to the initial listing of the Site on the Interim Priorities List were divided into eleven operable units, the 12th and Quivas properties being Operable Unit I. The properties were divided based primarily upon site conditions and proximity to other Denver Radium Site properties.

In April, 1986, the Denver Radium Site Remedial Investigation Report, which addresses all eleven operable units, was finalized. The draft Operable Unit I FS was released for public review on August 3, 1987. Responses to comments received during the public comment period are contained in the Responsiveness Summary attached to this Record of Decision. The final Operable Unit I FS is comprised of the draft Operable Unit I FS incorporating the changes described in the errata. Pursuant to SARA Section 104(i), the draft Operable Unit I FS was submitted for review by the Agency for Toxic Substances and Disease Registry (ATSDR). At the signing of this ROD, ATSDR had not formally responded. However, preliminary discussions with ATSDR indicated that ATSDR had no major criticisms of the report.

Site Location and Description

The Denver Radium Site, located in Denver, Colorado (population 509,000), consists of more than 40 contaminated properties. These properties have been grouped into operable units. Operable Unit I consists of the following Denver Radium Site properties, also known collectively as the 12th and Quivas properties:

- B&C Metal Products
- Erickson Monuments
- Materials Handling Equipment Company
- Rudd Investments
- Denver and Rio Grande Western Railroad (DRGRR)

The 12th and Quivas properties are located in the Platte River Valley but are not within the designated 100-year flood plain. The properties are underlain by fill material, alluvium, and the Denver formation sandstone. Depth to ground water is 14 feet and depth to bedrock is 16 feet. The topography of the of the site is predominately flat, however, a north-south ridge of approximately ten feet in height runs along the eastern portion of the site. There is no surface water on the 12th and Quivas properties; however, occupants of some of the properties report that storm water drainage in the area can be a problem at times. The climate of the area is typified by low annual precipitation, averaging about 14 inches per year.

The 12th and Quivas properties are located in an area of Denver currently zoned I-1 for industrial use. The properties cover approximately 8.1 acres and are bounded on the east by Quivas Street, on the north by West 13th Avenue, on the west by Shoshone Street, and on the south by West 12th Avenue (Figure 2). There are buried municipal utilities within these boundaries.

B&C Metal Products is located at 1623 West 12th Avenue. The property is sparsely vegetated with weeds and trees. The only structures on the property are a two-story stone and brick building with a basement and a storage shed. The building is occupied by 12 people approximately 40 hours per week. The building covers 20,700 square feet of the 33,100-square-foot lot owned by B&C Metal Products.

The Erickson Monuments property, located at 1241 Quivas Street, covers approximately 29,800 square feet. A railroad spur cuts diagonally across the property. Sandblasting grit and waste granite, mixed with fill material, has been regraded to create an area on the northern end of the property which is three to five feet higher in elevation than the surrounding property. Spent silicon carbide sandblasting grit has been scattered over the entire property. Both finished and unfinished monuments have been placed over a large portion of the property. There are two connecting, single-story buildings on the property. One is made of frame and steel and the other is a small brick building. Six people work at the property approximately 40 hours per week.

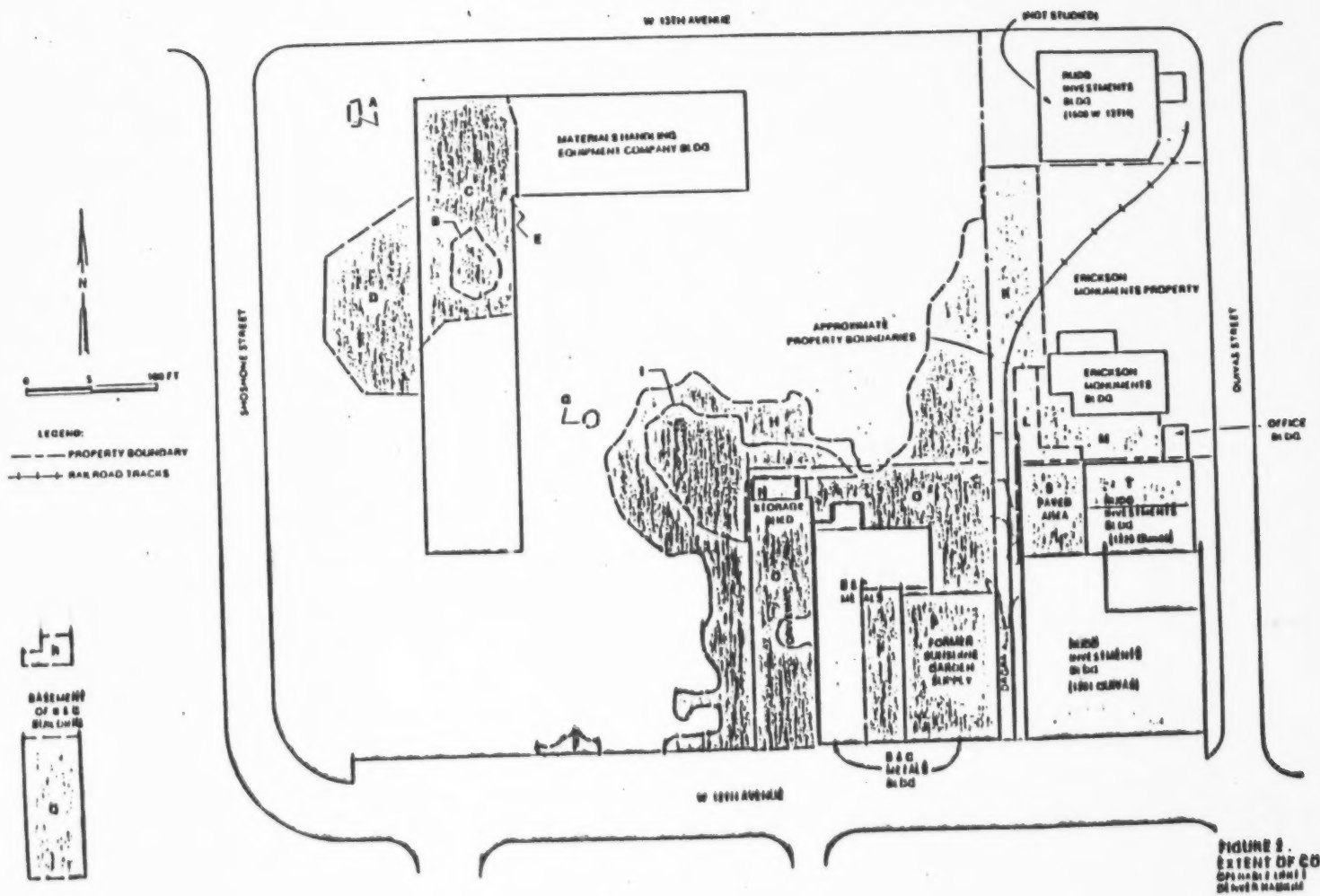

FIGURE 2.
EXTENT OF CONTAMINATION

The Materials Handling property is the largest of the 12th and Quivas properties, occupying 5.4 acres at 1740 West 13th Avenue. The company employs 65 people 40 hours per week. These people work in a single brick and concrete building on the property.

The Rudd Investments property is located at 1229 Quivas Street. A brick building on the property is occupied by 16 to 18 people between 40 and 50 hours per week. The west part of the property is an asphalt-paved, fenced, storage area which contains one sheet-metal storage shed.

The DRGRR property is a road easement that was once used for railroad access. With time and disuse, the tracks have become covered with dirt and are only visible in certain areas.

Current Site Status

Radium and its associated decay products are the primary contaminants of concern at the 12th and Quivas properties. Since gamma radiation readings in excess of background may indicate the presence of radium, a gamma radiation survey was used to outline the extent of possible radium contamination on the 12th and Quivas properties (Shaded areas of Figure 2). Gamma radiation readings in excess of background were found over 95,500 square feet of the properties including areas inside several buildings. Average gamma radiation measurements ranged from 2 microroentgen per hour (μR/hr) to 50 μR/hr above background. The maximum gamma radiation measurement was 510 μR/hr above background. (A general discussion of radiation and its associated units of measurement is presented in Appendix A of the Operable Unit I FS and in the Public Health and Environmental Assessment, Appendix B of the Operable Unit I FS.)

The presence of radium in the soil and underneath the buildings was verified by radiochemical analysis of subsurface soil samples. The volume-weighted average radium concentration in the contaminated soils on the 12th and Quivas properties was determined to be 108 picocuries per gram (pCi/g). The maximum radium concentration found on the properties was 1,920 pCi/g. Radium contamination was found to a maximum depth of 132 inches from the surface. The estimated total volume of radium-contaminated soil on the 12th and Quivas properties is 11,000 cubic yards of which over 3,000 cubic yards lie under structures. Table 1 summarizes the gamma radiation and radium concentration data collected on the 12th and Quivas properties.

The B&C Metal Products, the Materials Handling, and the Rudd Investments buildings on the 12th and Quivas properties contained elevated radon decay product concentrations resulting from the radium contamination on the properties. During a 1984 EPA investigation, a radon decay product concentration of 0.135 working level (WL) was detected in the east end of the B&C Metal Products building basement. In response, EPA installed a

Table 1
SURFACE AND SUBSURFACE CONTAMINATION
OPERABLE UNIT I, DENVER RADIUM SITE

Location	Volume (yd^3)	Area (ft^2)	Gamma (μR/hr) Average	Gamma (μR/hr) Maximum	Depth[a] (in.)	Radium Concentration (pCi/g) Average	Radium Concentration (pCi/g) Maximum
Area A	7	200	9	10	12	NA	NA
Area B	329	1,271	5	11	84	68.2	430
Area C	808	8,610	4	11	6 to 36 Avg: 30	39.8	124
Area D	521	7,038	8	32	24	117	750
Area E	8	203	9	11	12	21.9	37
Area F	25	450	7	13	18	15.2	19
Area G	17	100	4	4	54	25.1	63
Area H	1,068	11,538	14	42	12 to 42 Avg: 30	50.4	320
Area I	2,054	6,525	50	510	72 to 132 Avg: 102	256.9	1,920
Area J	229	6,175	10	23	12	114.5	220
Area K	121	6,537	11	26	6	22	54
Area L	378	2,042	14	47	60	53.6	251
Area M	220	5,942	8	16	12, to 24 Avg: 18	18.3	29
Area N	236	850	24	52	90	NA	NA
Area O	2,528	17,895	29	270	12 to 54 Avg: 46	94	452
Area P	1,456	10,649	2	---	Avg: 48	62	115
Area Q	181	2,940	6	29	Avg: 20	1	1
Area R	137	718	9	10	Avg: 62	NA	NA
Area S	356	3,325	17	91	16 to 46 Avg: 35	160	247
Area T	275	2,486	3	7	Avg: 36	10	10
Total	10,954	95,494			Maximum Depth: 132		

[a]Depth indicates the estimated depth of contamination. A range indicates a variation in the depth of contamination.

NOTES: Maximum gamma is maximum grid scan gamma. Gamma readings are net corrected readings above background level of 15 μR/hr.

NA = Data not available or not recorded for this area.

vented-plenum wall in the basement. After installation of this wall, the radon decay product concentration in the B&C Metal Products building dropped to 0.058 WL. The maximum radon decay product concentration measured in the Materials Handling building was 0.0512 WL and the maximum concentration measured in the Rudd Investments building was 0.180 WL. Although these levels exceed the limits allowed by EPA standards for radon, further emergency response actions were not taken at the 12th and Quivas properties because the patterns of occupancy and the concentrations of radon decay products present during periods of occupancy reduced the likelihood of significant long-term exposure. The complete set of radon decay product concentration data collected for the 12th and Quivas properties is presented in Table 2-2 in the Operable Unit I FS.

The radium concentrations, the gamma radiation levels, and the radon decay product concentrations found on the 12th and Quivas properties exceed the "EPA Standards for Remedial Actions at Inactive Uranium Processing Sites," 40 CFR Part 192, which EPA has determined are relevant and appropriate Federal requirements for the 12th and Quivas properties. These standards are discussed later in this summary in the section entitled "Statutory Determinations".

The elevated concentration of radium at the 12th and Quivas properties poses a health hazard due to three principal potential exposure pathways. In order of decreasing significance, they are: (1) inhalation of radon gas, which is the immediate decay product of radium, and radon's own short-lived decay products, (2) direct gamma radiation exposure from the decay of radium and its progeny, and (3) ingestion or inhalation of radium-contaminated materials. Since radium is in a form that is relatively insoluble, and since migration of radiological contaminants into the ground water has not been noted, ingestion or contact with contaminated ground water is not one of the principal potential exposure pathways. Each of the three principal exposure routes will be discussed briefly in terms of the potential health risks associated with each exposure route.

Inhalation of Radon Decay Products:

Radon gas and its decay products present the greatest health risk from long-term exposure. Radon gas decays to a series of short-lived particulates which are typically electrostatically charged at their formation and often attach themselves to airborne particles. If these contaminated particles are inhaled, then the lungs and other internal organs are exposed to the highly ionizing sub-atomic particles which the radon decay products emit. Prolonged inhalation of air with a high concentration of radon decay products has been conclusively shown to cause increased occurrence of lung cancer in uranium miners.

Dispersion quickly dilutes radon emanating from radium-contaminated ground. This mechanism will minimize the radon concentration in the air above the open areas of the 12th and

Quivas properties to such an extent that no one working on or living near the properties is presently at risk from exposure to radon and its associated decay products from this source. Radon decay products can concentrate to unacceptable levels in buildings built over contaminated ground if those buildings are energy efficient, that is, they have little exchange of indoor air with outdoor air. Three buildings on the 12th and Quivas properties exhibit concentrations of radon decay products exceeding the relevant and appropriate EPA standard. The current risks associated with these elevated radon decay product concentrations are believed to be small compared with possible future risks for the following reasons. First, the duration of exposure is limited due to the fact that people work there rather than live there. Second, during the times that people are working there, radon levels, and consequently exposures to radon, are reduced because the air exchange rate with the outdoors increases when people are entering and leaving the building, loading bays are standing open, etc.

Although the present public health risk from radon decay product exposure at the 12th and Quivas properties is comparatively minor for the reasons stated above, EPA has determined that a significant increase in public health risk would occur if (1) any of the contaminated material on the properties is spread closer to potential receptors, especially if it is used as fill or construction material, or (2) if any of the buildings on the 12th and Quivas properties are sealed to make them more airtight, or (3) if the properties are ever redeveloped for any use that involves occupancy in enclosed, energy efficient structures. The Public Health and Environmental Assessment for the 12th and Quivas properties summarized below and contained in Appendix B of the Operable Unit I FS presents projected cancer risks if EPA were to take no action at the properties and the properties were redeveloped in any of these ways.

If a building were constructed over Area I (See Figure 2), the most contaminated area on the 12th and Quivas properties, representing about 19% of the estimated total volume of contamination on the properties, and several conservative assumptions are made (such as lifetime exposure), the estimated radon decay product concentration in the building would average 1.54 WL with an estimated maximum concentration of 11.5 WL. The radon decay product concentration in a typical U.S. home is 0.005 WL and the relevant and appropriate EPA standard, 40 CFR Part 192, is 0.02 WL. The average projected cancer risk (excluding background) to individuals working in such a building ranges from 1,500 to 4,300 cancer deaths per 10,000 persons exposed. The average projected cancer risk to individuals living in such a building ranges from 4,800 to 7,800 cancer deaths per 10,000 persons exposed.

These risk values can be compared to the average projected cancer risk if the radon decay product concentration in the building was 0.02 WL, the EPA standard. In this case, the projected cancer risk to individuals working in such a building

ranges from 23 to 91 cancer deaths per 10,000 persons exposed. The average projected cancer risk to individuals living in such a building ranges from 130 to 500 cancer deaths per 10,000 persons exposed. If the radon decay product concentration in the building was that of a typical U.S. home, 0.005 WL, then the projected cancer risk to individuals living in the building would range from 33 to 130 cancer deaths per 10,000 persons exposed. It should be noted that these projected cancer risk numbers do not include the EPA-estimated spontaneous risk of lung cancer, that is, the risk not attributable to either smoking or radon. Table 2 presents the information stated above.

Gamma Radiation Exposure:

The radioactive decay of radium and its decay products results in the emission of highly penetrating gamma radiation. Gamma radiation is of concern because it can easily penetrate a few centimeters of soil to give anyone standing over a contaminated area a reasonably uniform irradiation over the whole body. The greater the duration or intensity of this exposure, the larger the dose, and hence the greater the risk of adverse health effects. In the case of the 12th and Quivas properties, the gamma radiation emission is limited to the area immediately above the contamination.

As discussed previously, EPA has determined that a significant increase in public health risk would result if any of the contaminated material on the 12th and Quivas properties was disturbed and misused or if the area was redeveloped. If a building was constructed over Area O (See Figure 2), the largest area of contamination on the 12th and Quivas properties representing about 19% of the estimated total area of contamination on the properties, the estimated annual dose to a person working in the building would average 58 millirem per year (mrem/yr) with an estimated maximum annual dose of 543 mrem/yr. The estimated annual dose to a person living in a building built over Area O would average 191 mrem/yr with an estimated maximum annual dose of 1770 mrem/yr. These doses are in addition to the background dose of 130 mrem/yr incurred by those living in the Denver area and resulting from cosmic, terrestrial, and internal sources. The National Council on Radiation Protection and Measurements (NCRP) and the International Commission on Radiological Protection (ICRP) recommend a maximum allowable whole-body gamma radiation dose of 100 mrem/yr for members of the public in addition to natural background radiation and medical exposures they receive.

The projected cancer risk from gamma radiation (including background) to individuals working in a building built over Area O would average 29 cancer deaths per 10,000 persons exposed. The projected cancer risk to individuals living in the building would average 39 cancer deaths per 10,000 persons exposed. If individuals in any building were to receive a lifetime gamma radiation dose equivalent to that of the relevant and appropriate EPA standard, 40 CFR Part 192, then the projected cancer risk to

Table 2
PROJECTED CANCER RISKS
OPERABLE UNIT I
DENVER RADIUM SITE

Scenario	Exposure	Average Cancer Deaths Per 10,000 Persons Exposed	
Radon Decay Products:			
Building constructed over Area I	1.54 WL	Workplace	1500 to 4300
		Residential	4800 to 7800
EPA Standard*	0.02 WL	Workplace	23 to 91
		Residential	130 to 500
Typical U.S. Home	0.005 WL	Residential	33 to 130
Gamma Radiation:			
Building constructed over Area 0	29 μR/hr	Workplace	29**
		Residential	39**
EPA Standard*	20 μR/hr	Workplace	31**
		Residential	53**
Background	15 μR/hr	Residential	27

* 40 CFR Part 192
** In addition to risk from exposure to background gamma radiation levels.

those working in the building would average 31 cancer deaths per 10,000 persons exposed and the projected cancer risk to those living in the building would average 53 cancer deaths per 10,000 persons exposed. The projected cancer risk to individuals receiving a lifetime dose resulting from the Denver area background would be 27 cancer deaths per 10,000 persons exposed. It should be noted that cancer risks resulting from gamma radiation exposure are in addition to those resulting from inhalation of radon decay products. Table 2 presents the information stated above.

Inhalation or Ingestion of Radium-Contaminated Material:

Inhalation of the long-lived radionuclides like uranium, thorium, and radium is possible for persons living or working on or near the 12th and Quivas properties. Airborne particulate matter may contain small concentrations of these radionuclides resulting in a potential human exposure pathway. Direct ingestion of long-lived radionuclides is another potential human exposure pathway which can result in significant doses to various internal organs of the body. However, studies by the United States Department of Energy have shown that the projected radiation doses from these sources are many times smaller than those estimated for either radon decay product inhalation or direct gamma radiation exposure using even the most conservative assumptions. Also, it is unlikely that a person would ingest large amounts of the radium-contaminated material on the 12th and Quivas properties and dust control measures ordinarily employed during excavation have been shown to provide sufficient control of exposure from inhalation of radium-contaminated material. For these reasons, EPA acknowledges these human exposure pathways, but no quantitative risk numbers were developed in the Public Health and Environmental Assessment for the 12th and Quivas properties.

It is clear that a release or substantial threat of release of a hazardous substance or pollutant or contaminant into the environment has occurred at the 12th and Quivas properties and the release or threat of release may present an imminent and substantial endangerment to public health. It is also clear from the calculated risks that remedial action at the 12th and Quivas properties is justified.

Enforcement

A detailed responsible party search for the entire Denver Radium Site has been initiated. Regarding the 12th and Quivas properties, records show that Pittsburgh Radium Company operated a processing facility at this location at the time of apparent disposal of ore processing wastes containing, among other contaminants, radium, the hazardous substance of concern. Although extensive investigation has been conducted, the responsible party search has yet to trace the Pittsburgh Radium

Company to a viable, present-day company. At this point, the responsible party search has not revealed that the present owners of the 12th and Quivas properties have any record of having been connected with the activities that caused the site to be radiologically contaminated.

EPA does not feel that response actions should be delayed pending finalization of the responsible party search. Upon finalization of the search, the status of responsible parties will be determined and evaluated and, if appropriate, EPA will formally notify them of the selected remedy for the 12th and Quivas properties and initiate negotiations for the implementation of the remedy. If the responsible parties do not formally commit to performing the remedy in a timely manner, EPA will proceed with a Fund-financed remedial design and remedial action and will attempt to recover EPA's response costs from the responsible parties.

Community Relations History

On August 1, 1987, and again on August 2, 1987, the Proposed Plan for the 12th and Quivas properties was published in both the Rocky Mountain News and the Denver Post. The display ads announced the August 3 through 21, 1987 public comment period and the August 12 public meeting, gave a brief description of the remedial action alternatives, and stated the rationale for the Proposed Plan. The display ads also included a statement asserting the State of Colorado's support of the Proposed Plan.

In addition to publishing the Proposed Plan, EPA issued a press release announcing the public comment period. The press release, along with the Executive Summary of the Operable Unit I FS, was mailed to the approximately 300 names on the EPA-compiled Denver Radium Site mailing list.

On July 10, 1987, EPA met with the owners and tenants of the 12th and Quivas properties. The owners and tenants who attended the meeting expressed concern about adverse publicity which they might receive resulting from any press coverage of EPA's Proposed Plan. They also were interested in the details of the remedial action phase, in particular, how remedial action would affect their business operations. On August 12, 1987, EPA held a public meeting concerning the 12th and Quivas properties. Major concerns raised by those who attended the meeting were how the remedial action at the properties would affect the business operations of the owners and tenants and the liability of the owners and tenants.

In general, the public supports the complete excavation and permanent offsite disposal of all Denver Radium Site material including the contaminated material present on the 12th and Quivas properties. The community has reservations about any temporary response action which EPA may take because of concerns that the State of Colorado will not make available a permanent

disposal site for this material and, therefore, no permanent measures will ever be implemented at the properties. The portion of the community in the vicinity of the Card Corporation property (See Figure 1) strongly opposes temporary storage at the Card Corporation property, Operable Unit X of the Denver Radium Site, again because of concerns that the State of Colorado will not make available a permanent disposal site and that the temporary storage facility on the Card Corporation property will become permanent, resulting in a decrease in property values in the area.

The Responsiveness Summary attached to the ROD contains the official transcript of the public meeting, describes in more detail the nature and level of the community's concern, and includes EPA's responses to all comments received during the public review of the Operable Unit I FS.

Alternatives Evaluation

EPA evaluated potential remedial action alternatives for the 12th and Quivas properties primarily by progressing through the series of analyses which are outlined in the National Contingency Plan (NCP), in particular, 40 CFR Section 300.68; the Interim Guidance on Superfund Selection of Remedy, December 24, 1986, (OSWER Directive No. 9355.0-19); and the Additional Interim Guidance for FY '87 Records of Decision, July 24, 1987, (OSWER Directive No. 9355.0-21). This process, in part, enables EPA to address the SARA Section 121 requirements of selecting a remedial action that is protective of human health and the environment, that is cost-effective, that attains Federal and State public health and environmental requirements that are applicable or relevant and appropriate, and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Additionally, SARA Section 121 and the guidance documents referenced above require EPA to give preference to remedies which employ treatment which permanently and significantly reduces the toxicity, mobility, or volume of hazardous substances as their principal element.

The selection of remedy process begins by identifying certain site-specific information to be assessed in determining the types of response actions that will be considered for the site. A general list of site-specific information to be considered in this process is contained in Section 300.68(e)(2) of the NCP. This list was used to identify specific site and waste characteristics of the 12th and Quivas properties. (See Table 5-1 of the Operable Unit I FS.) Based upon these site and waste characteristics, EPA was able to scope, from the universe of all possible response actions, a set of response actions and associated technologies to be considered for the 12th and Quivas properties. An example of this scoping process was the elimination of the use of sedimentation basins from further consideration because surface water contamination is not a

characteristic of the 12th and Quivas properties. Appendix D of the Operable Unit I FS illustrates the scoping process and Table 5-2 of the Operable Unit I FS details the results.

Section 121(b)(1) of SARA requires that an assessment of permanent solutions and alternative treatment technologies or resource recovery technologies that, in whole or in part, will result in a permanent and significant decrease in the toxicity, mobility, or volume of the hazardous substance, pollutant, or contaminant be conducted. As part of this process, EPA evaluated permanent solutions to the problems associated with the specific hazardous substances present on the 12th and Quivas properties. The alternative treatment and resource recovery technologies considered included, among others, in-situ vitrification and reprocessing.

Before the technologies were assembled into remedial action alternatives, they were categorized as either source control or management-of-migration measures and then prescreened based on their suitability to abate the threat at the 12th and Quivas properties. Source control measures are intended to contain the hazardous substances onsite or eliminate the potential for contamination altogether by transporting the hazardous substances to a safer location. Management-of-migration actions are taken to minimize or mitigate the migration of hazardous substances. The result of the prescreening of both source control and management-of-migration measures based on their suitability to abate the threat at the 12th and Quivas properties is presented in Table 5-3 of the Operable Unit I FS.

The next step of the selection of remedy process is assembling the remaining technologies and/or disposal options into remedial action alternatives. Pursuant to OSWER Directive No. 9355.0-19, "Interim Guidance on Superfund Selection of Remedy", remedial action alternatives are to be developed ranging from those that would eliminate the need for long-term management (including monitoring) at the site to alternatives involving treatment that would reduce toxicity, mobility, or volume as their principal element. Remedial action alternatives developed in this way will vary mainly in the degree to which they rely on long-term management of treatment residuals or low-concentration wastes. Further, a containment option involving little or no treatment and a no-action alternative are to be developed. Remedial action alternatives developed in the Operable Unit I FS for the 12th and Quivas properties were:

1. No Action

2. Deferred Removal, Offsite Permanent Disposal

3. Onsite Reprocessing/Treatment, Offsite Permanent Disposal

4. In-Situ Vitrification

5. Onsite Permanent Disposal

6. Offsite Permanent Disposal

7. Onsite Temporary Land Storage, Offsite Permanent Disposal

8. Onsite Temporary Building Storage, Offsite Permanent Disposal

9. Onsite Temporary Containment (Capping), Offsite Permanent Disposal

10. Temporary Building Storage at the Card Corporation Property (OU X), Offsite Permanent Disposal

Alternatives 2, 3, 6, 7, 8, 9, and 10, since they require the permanent offsite disposal of contaminated material, would eliminate the need for long-term management (including monitoring) at the 12th and Quivas properties. Alternatives 3 and 4 involve treatment as their principal element, but do not necessarily reduce the mobility, toxicity, or volume of the waste. Alternatives 4 and 5 require permanent onsite remedies, and hence, long-term management and monitoring at the 12th and Quivas properties. Alternatives 5, 7, 8, and 9 are containment options - Alternative 5 requiring permanent onsite containment and Alternatives 7, 8, and 9 requiring temporary onsite containment. Finally, No Action was included as Alternative 1.

Alternative 6, Offsite Permanent Disposal, is not immediately implementable because the State of Colorado has not at this time designated a facility for the disposal of the Denver Radium Site wastes. Pursuant to CERCLA Section 104(c)(3)(C)(ii), it is the responsibility of the State to assure the availability of a disposal site. Also, in order to comply with SARA Section 104(k), and in order to assure that remedial actions within Colorado continue, the State must provide adequate assurance of the availability of a hazardous waste treatment or disposal facility within three years from the effective date of SARA, October 17, 1986. Although progress is being made to this end, the State does not expect to have a fully operational disposal facility prior to implementation of any remedial action and possibly for up to five years. In the meantime, in its presently uncontrolled state, the radium-contaminated material at the 12th and Quivas properties could be misused or inadvertently spread, possibly increasing the risk to present or future public health or the environment. In addition, the cost of final remedial action is expected to increase due to inflation; the 12th and Quivas property owners and tenants face economic losses associated with restricted use of their properties; and EPA may incur further cost by updating site studies in face of changing site conditions. For these reasons, EPA determined that in order to effectively mitigate or minimize short-term threats to and provide adequate protection of public health and the environment

at the 12th and Quivas properties developing remedial action alternatives which include temporary response actions was appropriate. Thus, Alternatives 7, 8, 9, and 10 were developed to reduce existing risks by including temporary response measures followed by permanent offsite disposal of the contaminated material when a facility for such disposal becomes available.

Initial screening, which is the next step in the selection of remedy process, narrows the list of potential remedial action alternatives. Consistent with Section 300.68(g) of the NCP and the OSWER Directive 9355.0-19, the remedial action alternatives developed for the 12th and Quivas properties were initially screened using the criteria of cost, implementability (acceptable engineering practices), and effectiveness. Table 7-1 in the Operable Unit I FS summarizes the initial screening process. Alternatives 1, 2, 7, 8, 9, and 10 passed the initial screening and were carried forward for detailed analysis, while Alternatives 3, 4, 5, and 6 were screened out primarily for the reasons set forth below.

Alternative 3, Onsite Reprocessing, was eliminated from further consideration based on its lack of effectiveness. The residuals from this process, both the reprocessed soil and the concentrated precipitate resulting from the reprocessing of the soil, would require disposal in a facility that meets the requirements of 40 CFR Part 192. These residuals would retain many of the toxicity and mobility characteristics of the untreated material and, in addition, the volume would not be significantly affected. This remedial action alternative would provide no additional benefit to public health or the environment over other remedial action alternatives to be considered.

Alternative 4, In-Situ Vitrification, was eliminated during the initial screening because its implementability and effectiveness for this particular application is unproven. In-situ vitrification has not been demonstrated on a large scale or utilized in a highly-populated urban area like that of the 12th and Quivas properties. The extreme temperature requirements of this process could cause unknown damage to onsite structures and buried utilities and tanks. Once vitrified, a cap over the area would be necessary to limit the escape of radon gas; thus, this alternative does not affect toxicity or persistence of the contaminated material. Furthermore, the property would have to be permanently dedicated as a disposal site and measures would have to be taken to prevent human contact with or disturbance of the vitrified material. Finally, this remedial action alternative would require long-term government ownership, licensing, management, and monitoring to protect the integrity of the cap and the vitrified mass. These requisites would conflict with current and proposed land uses for the area, as well as State policies on siting permanent disposal facilities, (6 CCR 1007-1, Part III, Schedule E, Criterion 1). The State siting objectives specify, among other things, that permanent disposal facilities must be located away from populated areas and that hydrogeologic and other environmental conditions be

conducive to continued immobilization and isolation of contaminants from usable ground water sources. These criteria are clearly not met at the 12th and Quivas properties which are located within a metropolitan area, and where the depth to ground water is only 10 to 15 feet.

With the elimination of these two remedial action alternatives, no remedial action alternative which involves treatment as a principal element survives the initial screening. However, EPA has no reasonable belief that either of these remedial action alternatives is equally protective as other remedial action alternatives being considered, or offers the potential for better treatment performance or implementability, lesser adverse impacts, or lower costs than demonstrated remedial action alternatives.

Alternative 5, Onsite Permanent Disposal, was eliminated from further consideration because of implementability and effectiveness factors. The property would have to be permanently dedicated as a disposal site and measures would have to be taken to isolate the contaminated material from man and the environment for a thousand years without ongoing active maintenance. This objective would be difficult to attain in an urban area where there is a high potential for human disturbance and in an area where the ground water is fairly close to the surface as it is on the 12th and Quivas properties. This remedial action alternative would require long-term government ownership, licensing, and management and monitoring to protect the integrity of the facility. These requisites would conflict with current and proposed land uses for the area, as well as State policies on siting permanent disposal facilities (6 CCR 1007-1, Part III, Schedule E, Criterion 1) discussed above.

Alternative 6, Offsite Permanent Disposal, is not implementable at this time because the State of Colorado has yet to designate a facility for the disposal of Denver Radium Site wastes and was therefore eliminated during initial screening.

Following is a description of the remedial action alternatives surviving the initial screening.

1. No Action

   If this remedial action alternative were selected, no action would be taken at the contaminated 12th and Quivas properties. This alternative serves as a baseline and was retained for further analysis and consideration as required by Section 300.68(f)(1)(v) of the NCP.

2. Deferred Removal, Offsite Permanent Disposal

   If this remedial action alternative were selected, removal of the contaminated material at the 12th and Quivas properties would be deferred until an approved

offsite permanent disposal facility is identified and made available by the State of Colorado. Once this facility becomes available, the entire estimated 11,000 cubic yards of contaminated material on the 12th and Quivas properties including the contaminated material under the B&C Metal Products, Materials Handling, and Rudd Investments buildings would be excavated and transported by either truck or rail for final disposal at this facility. The 12th and Quivas properties would then be available for unrestricted use.

7. Onsite Temporary Land Storage, Offsite Permanent Disposal

If this remedial action alternative were selected, the approximately 11,000 cubic yards of contaminated material on the 12th and Quivas properties would be excavated and temporarily stored on the site. An asphalt pad would be constructed in an open area of the eastern portion of the Materials Handling property. Contaminated material would be placed on the pad and covered with a suitable material. Security precautions, inspections, and radiation monitoring of the storage facility would be instituted. Once a suitable offsite permanent disposal facility becomes available, the contaminated material would be transported by either rail or truck to the facility. The 12th and Quivas properties would then be available for unrestricted use.

8. Onsite Temporary Building Storage, Offsite Permanent Disposal

If this remedial action alternative were selected, the approximately 11,000 cubic yards of contaminated material on the 12th and Quivas properties would be excavated and placed in containers. The containers would be temporarily stored in a newly constructed building on the 12th and Quivas properties. Security precautions, inspections, and radiation monitoring of the storage facility would be instituted. Once a suitable offsite permanent disposal facility becomes available, then the contaminated material would be transported by either rail or truck to the facility. Upon removal of the containers, the building would be decontaminated and either dismantled or left in place. The 12th and Quivas properties would then be available for unrestricted use.

9. Onsite Temporary Containment (Capping), Offsite Permanent Disposal

If this remedial action alternative were selected, the identified open areas of contamination on the 12th and Quivas properties would be capped. Contaminated soil

under the B&C Metal Products, Materials Handling, and Rudd Investments buildings would be excavated and consolidated on the eastern portion of the Materials Handling property in a temporary storage facility. Access restrictions would be required to limit disturbance of the cap. Security precautions, inspections, and radiation monitoring of the storage facility and the cap would be instituted. Once a suitable offsite permanent disposal facility becomes available, the contaminated material would be transported by either rail or truck to the facility. The 12th and Quivas properties would then be available for unrestricted use.

10. Temporary Building Storage at the Card Corporation Property (OU X), Offsite Permanent Disposal

    If this remedial action alternative were selected, a portion of the contaminated material on the 12th and Quivas properties would be excavated, placed in containers, and the containers transported to the Card Corporation Property (OU X) for temporary storage. The remaining material on the 12th and Quivas properties would be excavated and consolidated on the eastern portion of the Materials Handling property in a temporary storage facility. Security precautions, inspections, and radiation monitoring of the storage facilities on both operable units would be instituted. Once a suitable offsite permanent disposal facility becomes available, the contaminated material from both operable units would be transported by either rail or truck to the facility. The 12th and Quivas properties, as well as the Card Corporation property, would then be available for unrestricted use.

Consistent with Section 300.68(h) of the NCP, the OSWER Directive No. 9355.0-19, and the OSWER Directive No. 9355.0-21, the remedial action alternatives remaining after initial screening were further refined and then subjected to detailed analysis. Detailed analysis of each remedial action alternative entailed evaluation based on the three broad criteria of implementability, effectiveness, and cost. For each of these broad criteria, EPA identified appropriate and more specific "component measures" so that the remedial action alternatives could be compared to each other using a full array of evaluation factors. The component measures derived for implementability, effectiveness, and cost were based upon specific requirements and criteria contained in Section 300.68(h)(2) of the NCP, SARA Sections 121(b)(1)(A through G), SARA Section 121(c), the discussion on detailed analysis contained in the OSWER Directive No. 9355.0-19, and the OSWER Directive No. 9355.0-21.

The component measures of implementability are: technical feasibility, constructability, reliability, administrative

concerns, availability of the technology, and operation and maintenance. The component measures of effectiveness are attainment of applicable or relevant and appropriate requirements (ARARs); effectiveness in significantly and permanently reducing mobility, toxicity, and volume; persistence, toxicity, mobility, and propensity to bioaccumulate of the hazardous substances and their constituents; protectiveness/health effects; environmental protectiveness/potential for adverse environmental impacts; and compliance with the Solid Waste Disposal Act. The component measures of cost are: capital cost, operation and maintenance costs, and potential future remediation costs if the alternative fails. Section 8 of the Operable Unit I FS provides a comparative review of the remedial action alternatives based upon each of the component measures listed above.

Implementability Analysis:

All of the alternatives which were analyzed in detail are technically feasible and constructable as they rely on common earth moving and construction technologies - technologies which are both operationally reliable and readily available. Although technically feasible, Alternative 7, Onsite Temporary Land Storage, Offsite Permanent Disposal, and Alternative 8, Onsite Temporary Building Storage, Offsite Permanent Disposal, are the most difficult remedial action alternatives to implement because of the limited space on the 12th and Quivas properties where either a land-storage or building-storage facility could be constructed with enough capacity to contain the entire volume of material from the properties. The necessary equipment and specialists for implementation of any of the remedial action alternatives are readily available. Remedial action work similar to that envisioned in any of the remedial action alternatives is already being safely conducted in Grand Junction, Colorado, under the auspices of the United States Department of Energy Uranium Mill Tailings Remedial Action Project.

No Action and Alternative 2, Deferred Removal, Offsite Permanent Disposal, are administratively the easiest alternatives to implement. The need to coordinate and obtain access agreements with the 12th and Quivas property owners and the need to obtain necessary approvals and non-environmental construction permits from other offices and agencies are administrative implementation constraints common to all of the remedial action alternatives with the exception of No Action. Alternative 10, Temporary Building Storage at Card Corporation Property (OU X), Offsite Permanent Disposal, has an additional implementation constraint, that is, an agreement with the Mentor Corporation, current owner of the Card Corporation property, to allow for storage of other Denver Radium Site wastes on the Card Corporation property must be finalized.

All remedial action alternatives except No Action and Alternative 2 require a limited degree of operation and maintenance activities. The final response action associated with the remedial action alternatives, permanent offsite

disposal, cannot be implemented until the State of Colorado provides a facility suitable for the disposal of this material. This implementation constraint is common to all of the remedial action alternatives except No Action.

Effectiveness Analysis:

Alternatives 7, 8, and 10 will meet contaminant-specific ARARs for radium levels in site soils once the temporary response actions are completed. Alternative 10 is more protective, and thus more effective, than either Alternative 7 or 8 because a portion of the contaminated material, instead of being stored on the 12th and Quivas properties, would be removed from the properties entirely. Alternatives 2 and 9 are both less effective than either Alternative 7, 8, and 10 because Alternatives 2 and 9 will meet contaminant-specific ARARs only after the contaminated material from the properties is removed to the offsite permanent disposal facility. Alternative 9, is in turn more protective, and thus more effective, than Alternative 2 because the cap will provide interim protection to public health and the environment, whereas Alternative 2, will provide absolutely no short-term protection to the public health and the environment until the material can be removed to the offsite permanent disposal facility. In addition, Alternative 9 will reduce the chance of dispersal of contaminated material until the material can is removed. No Action will not meet the contaminant-specific ARARs for radium levels in soils on the 12th and Quivas properties and, therefore, will provide neither short-term or long-term protection of public health and the environment. The possible resulting exposure could result in unacceptable risks to public health and the environment.

Alternatives 7, 8, 9, and 10 will meet contaminant-specific ARARs for gamma radiation levels and radon decay product concentrations in the buildings once the temporary response actions are completed. Alternative 2 will meet these levels only after the contaminated material under the buildings is removed to the permanent disposal facility. No Action will not meet these contaminant-specific ARARs and the possible resulting exposure would result in unacceptable risks to public health.

No Action and, in the interim, Alternative 2 will not reduce the mobility, toxicity, or volume of the contaminated material on the properties. Although Alternatives 7, 8, 9, and 10 will not reduce the toxicity or volume of the radioactive waste, they transfer the contaminants from an uncontrolled status to a controlled facility, thereby reducing mobility. In addition, an increase in volume is often the result of the contaminated material being disturbed. Thus, Alternatives 7, 8, 9, and 10, since they reduce the chances of the material being disturbed, also may prevent the volume of contamination from increasing.

EPA conducted a Public Health Evaluation of Remedial Alternatives to determine short-term potential for adverse health effects from human exposure associated with the various remedial

action alternatives. This analysis, summarized in Appendix F of the Operable Unit I FS, revealed that all of the alternatives considered except No Action would result in nearly equivalent exposures during implementation of the remedy. In addition, all estimated exposures would be well below target levels established in ARARs. EPA also conducted a Public Health and Environmental Assessment to determine the long-term potential for adverse health effects associated with the contaminant levels present on the 12th and Quivas properties. This analysis, summarized earlier in this summary and contained in Appendix B of the Operable Unit I FS, showed that there would be a significant increase in public health risk if the No Action alternative was implemented at the 12th and Quivas properties.

The potential for adverse environmental impacts at the 12th and Quivas properties is low. However, leaving the material on the properties in an uncontrolled state provides an opportunity for potential environmental impacts during a catastrophic event, such as a flood or water main break, resulting in a substantial dispersal of the contaminants.

Cost Analysis:

No Action is the least costly remedial action alternative followed by Alternative 2. Alternative 10 is the most expensive alternative followed closely by Alternative 8. Alternatives 7 and 9 have costs between the extremes, with Alternative 9 being slightly less expensive. Table 3 presents a breakdown of each remedial action alternative's cost based upon the component measures of cost described above. Even more detail is provided in Appendix G of the Operable Unit I FS. Section 8 of the Operable Unit I FS contains a sensitivity analysis of these costs.

In summary, the selected remedy for the 12th and Quivas properties was chosen from the detailed analysis of remedial action alternatives. The analysis was based upon component measures of implementability, effectiveness, and cost. Table 4 outlines the detailed analysis of remedial action alternatives summarized above. (See also Section 9 of the Operable Unit I FS.)

Selected Remedy

This Record of Decision addresses the contamination present on the 12th and Quivas properties, Operable Unit I of the Denver Radium Site . This is the fourth operable unit of the Denver Radium Site for which EPA has selected a remedy. EPA is undertaking additional feasibility studies to evaluate remedial action alternatives at the other Denver Radium Site operable units and will complete a Record of Decision or an Action Memorandum for each of the operable units for which a remedy has not already been selected.

Table 3

COST EVALUATION OF ALTERNATIVES
OUTBACK UNIT I, DENVER RADIUM SITE

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Selected Removal/ Offsite Permanent Disposal	Alternative 3 Onsite Temporary Land Storage/ Offsite Permanent Disposal	Alternative 4 Onsite Temporary Building Storage/ Offsite Permanent Disposal	Alternative 5 Onsite Temporary Containment (Capping)/ Offsite Permanent Disposal	Alternative 6 Onsite Temporary Building Storage at Cane Corporation (see 3)/ Offsite Permanent Disposal
Capital Costs						
• Initial	Not Applicable	$ 116,500	$3,035,500	$3,134,200	$1,087,900	$3,387,400
• Deferred (Present worth)	Not Applicable	1,805,300	1,893,200	1,888,200	1,484,900	1,829,500
Operation and Maintenance (Present Worth)						
• Short-term (up to 5 yr)	Not Applicable	89,100	199,800	487,400	859,600	494,500
• 5-yr site review	Not Applicable	31,000	31,000	31,000	31,000	31,000
Total Alternative cost	Not Applicable	$3,001,900	$5,059,500	$5,535,800	$3,383,600	$4,973,200
Potential Future Remedial Cost if Alternative Fails	Not Applicable	Minimal potential for future remedial costs because of low probability for failure of removal action	Minimum cost, if alternative fails, equals initial capital	Minimum cost, if alternative fails, equals initial capital	Maximum cost, if alternative fails, equals initial capital	Maximum cost, if alternative fails, equals initial capital

Table 4

SUMMARY OF ALTERNATIVE EVALUATION
OPERABLE UNIT I, DENVER RADIUM SITE

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Deferred Removal/ Offsite Permanent Disposal	Alternative 7 Onsite Temporary Land Storage/ Offsite Permanent Disposal
Implementability	Feasible.	OU I properties could undergo additional development in contaminated areas. Contaminated materials could be dispersed or diluted such that they would no longer be identifiable. Excavation cannot proceed until an offsite disposal facility is available. Availability required by SARA 104 (k). Facility is assumed not to be available until 1992.	Temporary storage can have technical problems, such as ripping of the synthetic liner or cracks in the asphalt pad. Temporary storage would be used until offsite disposal facility is available. Availability required by SARA 104(k). Facility is assumed not to be available until 1992. Site access restrictions and approvals would be needed to construct the asphalt pad storage unit. Storage facility would severely restrict usage of the Materials Handling property for 5 years, since it would occupy a large percentage of open space at the Materials Handling property.
Effectiveness	40 CFR 192 conditions for radium-226 in soils would not be attained. If the properties are redeveloped, protectiveness levels for radon would not be attained. As Low as Reasonably Allowable (ALARA) principle and NCRP/ICRP guidance for gamma radiation may not be met if land use changes or misuse of current situation occurs. No Action does not reduce mobility, toxicity, or volume of radioactive materials at OU I. Radioactive materials are extremely persistent. Radium is not very mobile and gives off radon decay products to the atmosphere. While not soluble after reprocessing, radium is subject to dispersal via human activity. Radon decay products can accumulate in human lungs and are carcinogens.	While removal is deferred, contaminant-specific ARAR's may not be met. ARAR's would be met upon removal.	ALARA principle and NCRP/ICRP gamma radiation values would be met. The mobility of the material will be decreased for erosional aspects. A synthetic liner may not reduce the mobility of radon gas on a long-term basis.

Table 4

(continued)

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Deferred Removal/ Offsite Permanent Disposal	Alternative 7 Onsite Temporary Land Storage/ Offsite Permanent Disposal
Effectiveness (continued)		During excavation, remedial action workers would be exposed to approximately 382 mrem/yr (whole body Dose Equivalent), which is below the 10 CFR 20 standard of 500 mrem/yr. Onsite workers who are not associated with cleanup would be exposed to approximately 7.9 mrem/yr, which is below the NCRP/ICRP guidance of 100 mrem/yr. Transportation of 350 miles to offsite disposal facility would involve driver exposure of 6.4 mrem/per trip. Minimal exposure (0.07 mrem) would occur to general public during transportation, unless an accidental spill occurred, which would result in a minor increase in exposures. Disposal facility would be compliant with regulations that assure protectiveness of human health.	The facility would be protective of the environment if appropriate liners and caps are used. Potential impacts could occur during removal (both for placement in the temporary facility and the offsite permanent facility) if uncontrolled dispersal occurs to the environment. During excavation, remedial action workers would be exposed to approximately 382 mrem/yr (whole body Dose Equivalent), which is below the 10 CFR 20 standard of 500 mrem/yr. Onsite workers who are not associated with cleanup would be exposed to approximately 3.4 mrem/yr, which is below the NCRP/ICRP guideline of 100 mrem/yr. Transportation exposures would be identical to Alternative 2.
Costs	Not Applicable	Capital PW[a]--$1,997,800 O&M[b] PW--100,100	Capital PW[a]--$3,628,700 O&M[b] PW--230,800

[a] PW = present worth at a 10 percent discount factor.

[b] O&M = Operations and Maintenance.

Table 4

(continued)

Evaluation Criteria	Alternative 8 Onsite Temporary Building Storage/ Offsite Permanent Disposal	Alternative 9 Onsite Temporary Containment (Capping)/ Offsite Permanent Disposal	Alternative 10 Onsite Temporary Building Storage at Card Corporation (OU X)/ Offsite Permanent Disposal
Implementability	Synthetic bags could rip and spill material in the building. However, the building should contain any spilled materials. Temporary storage would be used until offsite disposal facility is available. Availability required by SARA 104(k). Facility is assumed not to be available until 1992. Site access restrictions and approvals would be needed to construct the asphalt pad storage unit at the Materials Handling property. Storage facility would severely restrict usage of the property for 5 years, since it would occupy a large percentage of open space at the Materials Handling property.	Temporary containment can have technical problems, such as cracks in the asphalt pad. Temporary containment would be used until offsite disposal facility is available. Availability required by SARA 104(k). Facility is assumed not to be available until 1992. Site access restrictions and approvals would be needed to construct the temporary storage unit and cap at Materials Handling. Storage facility and cap would severely restrict usage of overall site for 5 years, since it would occupy a large percentage of open space at the property.	Synthetic bags could rip and spill material in the building. However, the building should contain any spilled materials. Temporary storage would be used until offsite disposal facility is available. Availability required by SARA 104(k). Facility is assumed not to be available until 1992. Approvals for using the Materials Handling property for radioactive material storage need to be obtained.
Effectiveness	Temporary storage facility would not meet 40 CFR 192 and 10 CFR 20 standards for gamma radiation and radon unless ventilation is used. However, radium standards in soils would be met upon initial removal. The mobility of the material would be decreased unless the container broke; however, the use of a building for storing the containers would contain any spillage. The mobility of radon gas could be decreased, but could still present a problem within the container building used for storage.	Capping and storage would not meet 40 CFR 192 and 10 CFR 20 standards. ALARA principle would be met. The mobility of the material will be decreased for erosional aspects. A synthetic liner may not reduce the mobility of radon gas, if land storage is implemented. If building storage is implemented, the mobility of radon gas could be decreased, but could still present a problem within the container building.	Temporary storage facility would not meet 40 CFR 192 and 10 CFR 20 standards for gamma radiation and radon unless ventilation is used. However, radium standards in soils would be met upon initial removal. The mobility of the material would be decreased unless the container broke; however, the use of a building for storing the containers would contain any spillage. The mobility of radon gas could be decreased, but could still present a problem within the container building used for storage.

Table 4

(continued)

Evaluation Criteria	Alternative 8 Onsite Temporary Building Storage/ Offsite Permanent Disposal	Alternative 9 Onsite Temporary Containment (Capping)/ Offsite Permanent Disposal	Alternative 10 Onsite Temporary Building Storage at Card Corporation (OU X)/ Offsite Permanent Disposal
Effectiveness (continued)	During excavation, remedial action workers would be exposed to approximately 382 mrem/yr (whole body Dose Equivalent), which is below the 10 CFR 20 guideline of 500 mrem/yr. Onsite workers who are not associated with cleanup would be exposed to approximately 3.1 mrem/yr, which is below the NCRP/ICRP standard of 100 mrem/yr. Transportation risks would be identical to Alternative 2.	During excavation, remedial action workers would be exposed to approximately 370 mrem/yr (whole body Dose Equivalent), which is below the 10 CFR 20 standard of 500 mrem/yr. Onsite workers who are not associated with cleanup would be exposed to approximately 4.5 mrem/yr, which is below the NCRP/ICRP guideline of 100 mrem/yr. Transportation exposures would be identical to Alternative 2.	During excavation, remedial action workers would be exposed to approximately 382 mrem/yr (whole body Dose Equivalent), which is below the 10 CFR 20 guideline of 500 mrem/yr. Onsite workers who are not associated with cleanup would be exposed to approximately 3.3 mrem/yr, which is below the NCRP/ICRP standard of 100 mrem/yr. Transportation risks would be slightly increased to 6.9 mrem per trip.
Costs	Capital PW[a]--$4,256,900 O&M[b] PW--518,400	Capital PW[a]--$3,412,800 O&M[b] PW--290,000	Capital PW[a]--$4,416,700 O&M[b] PW--556,500

[a] PW = present worth at a 10 percent discount factor.

[b] O&M = Operations and Maintenance.

EPA's preferred remedial action alternative for the 12th and Quivas properties is Alternative 6, Offsite Permanent Disposal. This alternative, however, was eliminated during the initial screening of remedial action alternatives because, until the State of Colorado provides a permanent disposal site for material from the 12th and Quivas properties, this alternative cannot be implemented. EPA has therefore determined that the appropriate extent of remedy at the 12th and Quivas properties is Alternative 9, Onsite Temporary Containment (Capping), Offsite Permanent Disposal. The State of Colorado has been consulted and concurs with the selected remedy.

Remedial Design for Operable Unit I will include the selected remedy, Alternative 9, and EPA's preferred remedial action alternative, Alternative 6, Offsite Permanent Disposal. Should the State of Colorado fulfill its obligation to assure the availability of a suitable disposal facility for material from the Denver Radium Site by the time EPA has concluded Remedial Design for the 12th and Quivas properties, EPA may immediately implement its preferred alternative, Offsite Permanent Disposal.

Description of the Selected Remedy:

The selected remedy consists of one temporary management-of-migration response action and one temporary source control response action followed by one final and permanent source control response action.

The temporary management-of-migration response action consists of placing a cap over the identified open areas of contamination which cover over 72,000 square feet of the 12th and Quivas properties, portions of which already have a permanent cap. The identified open areas of contamination account for an estimated 7,600 cubic yards of contaminated material. The cap will temporarily limit the spread of the contaminated material by wind and water erosion and human activity. The cap will also provide temporary protection of human health by reducing direct exposure to gamma radiation and by reducing the risk of inhalation or ingestion of contaminated soil. Placement of the cap could take one month. Once in place, the cap will be routinely inspected and restrictions on excavation will be instituted to maintain the integrity of the cap. The cap will remain in place until a permanent offsite disposal facility becomes available.

The temporary source control response action consists of excavating the estimated 3,400 cubic yards of contaminated material from under the B&C Metal Products, Materials Handling, and Rudd Investments buildings. Depending upon the structural details of each building, the contaminated material would be excavated either by partial demolition of the floor and excavating through the floor or by excavating from the exterior of the buildings. Excavation of the contaminated material from under the buildings could take three to six months. Contaminated material from under the buildings would be temporarily stored

onsite in either a land storage or building storage facility until a permanent offsite disposal facility becomes available.

The final and permanent source control response action will occur once a permanent offsite disposal facility becomes available and consists of removing the cap and excavating the material which was temporarily placed under the cap. This material, along with the material which had been temporarily stored onsite after having been excavated from under the buildings and any portion of the cap which is contaminated, would then be transported by either truck or rail to the permanent offsite disposal facility. Excavation of the contaminated material under the cap and transportation of the contaminated material to the permanent offsite disposal facility could take three to six months. A more detailed implementation schedule for this response action and the ones described above will be developed during Remedial Design.

The present-worth cost of the selected remedy is $3,702,800 based upon a ten-percent interest rate, a five-year discount period, and a perpetual monitoring period. The cost of this alternative includes placement of the cap over the contaminated open areas, construction of a temporary storage facility for material present under buildings, excavation of the material from under the buildings and placement of this material within the temporary storage facility, and maintenance and monitoring of the 12th and Quivas properties for a period of five years. The cost of this alternative also includes removal and transport of the contaminated material and the cap to the offsite permanent disposal facility, decontaminating and, if necessary, dismantling the temporary storage facility, and transporting the decontaminated material to a solid waste landfill.

Operation and maintenance activities will be required to ensure the effectiveness of the temporary response action. These activities include site inspections, ongoing radiological monitoring, and possible minor repairs to the cap or temporary storage facility. Also included as an operation and maintenance activity is a review of the properties which, pursuant to SARA Section 121(c), must be conducted no less than every five years if a remedial action is selected that results in any hazardous substances remaining onsite. Since EPA does not anticipate that any hazardous substances will remain onsite longer than five years, the cost of this review is considered a contingency. The maximum total of the discounted annual operation and maintenance costs of these activities using a five-year discount period and a ten-percent discount rate is $290,000. This operation and maintenance cost is included with the present-worth total alternative cost mentioned above.

Statutory Determinations:

Protectiveness: The Public Health and Environmental Assessment for the 12th and Quivas properties summarized earlier in this document clearly shows that there would be a significant

increase in the risk of contracting lung and other cancers if Alternative 1, No Action, was selected for this operable unit of the Denver Radium Site and the properties were ever developed in a way which might reasonably be expected. The only sure way to reduce this risk is excavation to achieve target residual levels established in contaminant-specific ARARs and removal of the contaminated material from the 12th and Quivas properties to an offsite permanent disposal facility. Further, because the offsite permanent disposal facility would be designed to isolate the contaminated material from man and the environment for a thousand years, the selected remedy would provide long-term protectiveness. The temporary measures envisioned in the selected remedy will provide the necessary short-term protectiveness.

In addition to preparing the Public Health and Environmental Assessment mentioned above, EPA conducted a Public Health Evaluation of Remedial Alternatives, summarized in Appendix F of the Operable Unit I FS. For this evaluation, exposures to gamma radiation, inhalation of contaminated soils, and inhalation of radon decay products were estimated for persons who might be exposed to hazards during implementation of each alternative undergoing detailed analysis. These persons include onsite remedial action workers, individuals not associated with remedial activities but working in an onsite office, residents of a home located outside of the property boundary, a transportation worker, and an onlooker present during truck transportation of the contaminated materials. Exposures were calculated for each remedial action alternative undergoing detailed analysis. The evaluation revealed that none of the estimated exposures for any scenario of any remedial action alternative, including the selected remedy, exceeded exposure limits set by the relevant and appropriate standard or guideline. Also, for any given scenario, there was no appreciable difference among the estimated exposures for the remedial action alternatives. The risks associated with this type of remedial action work lie not with possible radiological exposure, but with the inherent dangers associated with general construction work. Based upon statistics from the construction industry, EPA estimates that the number of worker non-fatal injuries would range from 1.16 to 1.20 for the type of work to be conducted during remedial action at the 12th and Quivas properties and the number of fatalities would range from 0.120 to 0.138 for the type of work to be conducted during remedial action. (See report entitled Operable Unit I, Public Health Assessment, Dose Commitments.) These numbers can be significantly reduced by hiring competent and properly trained construction contractors and by strict adherence to the site safety plan.

The OSWER Directive No. 9355.0-19 states, "Remedies must be protective of human health and the environment. This means that the remedy meets or exceeds ARARs..." EPA has determined that the selected remedy will meet all ARARs identified for the 12th and Quivas properties. In addition, from the analyses conducted in the Public Health and Environmental Assessment and the Public

Health Evaluation of Remedial Alternatives and because of the permanence associated with the design of the offsite disposal facility, EPA has concluded that the selected remedy would be protective of public health and the environment.

Consistency With Other Laws: Pursuant to SARA Section 121(d), remedial actions shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and control of further release which at a minimum assures protection of human health and the environment. In addition, remedial actions shall, upon their completion, reach a level or standard of control for such hazardous substances, pollutants, or contaminants which at least attains legally applicable or relevant and appropriate Federal standards, requirements, criteria, or limitations, or any promulgated standards, requirements, criteria, or limitations under a State environmental or facility siting law that is more stringent than any Federal standard (ARARs).

On November 20, 1986, EPA requested that the State of Colorado identify potentially applicable or relevant and appropriate State public health and environmental requirements for the Card Corporation property (OU X). The State responded to this request on January 21, 1987, with a list of Colorado requirements which the State believed pertained to the entire Denver Radium Site.

EPA classified all Federal and State public health and environmental requirements applicable or relevant and appropriate to the 12th and Quivas properties into three categories: contaminant-specific ARARs, action-specific ARARs, and location-specific ARARs. A description of each of these categories is provided in both Chapter 4 and Appendix C of the Operable Unit I FS. Other Federal and State criteria, advisories, and guidance were also considered. Tables C-1 through C-4 in Appendix C of the Operable Unit I FS contain a brief description of each potential Federal and State public health and environmental requirement identified and EPA's analysis of each requirement's applicability or relevance and appropriateness to the 12th and Quivas properties. EPA has determined that there are no applicable or relevant and appropriate public health and environmental requirements of Federal or State laws that the selected remedy will not meet and, therefore, no SARA Section 121(d)(4) waivers need be invoked. A brief discussion of ARARs for the 12th and Quivas properties is provided below.

The EPA Standards for Remedial Action at Inactive Uranium Processing Sites, 40 CFR Part 192, are one of two contaminant-specific ARARs identified for the 12th and Quivas properties. For properties contaminated with uranium processing residues, these standards establish limits for the gamma radiation level and annual average radon decay product concentration in any occupied or habitable building and for the radium concentration in soil on open lands. Although not applicable to the 12th and Quivas properties since the standards apply only to certain

specifically designated sites where uranium was processed, the standards are relevant and appropriate to the 12th and Quivas properties because (1) it is the radium content of the uranium mill tailings which is regulated; (2) the waste products resulting from uranium ore processing are very similar to those from both radium and vanadium ore processing; (3) the residues from both processes enter the environment through the same exposure pathways; and (4) the adverse health concerns resulting from exposure to the residues from both processes are the same.

The portion of the standards relevant and appropriate to the contaminated soil on the 12th and Quivas properties and the portion which serves as EPA's target residual level for cleanup is 40 CFR Section 192.12 which states:

"Remedial actions shall be conducted so as to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site:

(a) the concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than -

(1) 5 pCi/g, averaged over the first 15 centimeters of soil below the surface, and
(2) 15 pCi/g, averaged over 15-centimeter thick layers of soil more than 15 centimeters below the surface."

(40 CFR Section 192.12)

The portion of the standard relevant and appropriate to the buildings on the 12th and Quivas properties is 40 CFR Section 192.12(b) which states:

(b) In any occupied or habitable building -

(1) The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and
(2) The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

(40 CFR Section 192.12(b).)

The second contaminant-specific ARAR identified for the 12th and Quivas properties is the Nuclear Regulatory Commission Standards for Protection Against Radiation, 10 CFR Part 20. These regulations establish standards for protection against

radiation hazards arising out of activities under licenses issued by the Nuclear Regulatory Commission (NRC). Because these standards apply to licensed NRC facilities, they are not applicable to the 12th and Quivas properties. However, EPA has determined that portions of the regulations are relevant and appropriate to individuals who would be conducting the remedial action on the 12th and Quivas property. In addition, these regulations are incorporated by reference in the Occupational Safety and Health Administration Standards, 29 CFR Parts 1910 and 1926, which, due to the mandate contained in SARA Section 126, now apply to employees involved in responses covered by CERCLA.

Of particular importance is Appendix B of 10 CFR Part 20 which provides limits for airborne concentrations of natural uranium, thorium-230, and radium-226. Gamma radiation dose standards for individuals in restricted and unrestricted areas are cited in 10 CFR Sections 20.101 and 20.105, respectively. These 10 CFR Part 20 standards along with the 40 CFR Part 192 standards are summarized in Table 5.

Currently there are no identified Federal or State location-specific ARARs for the 12th and Quivas properties.

Action-specific ARARs are technology-based restrictions triggered by specific types of remedial measures under consideration. Once the remedial action alternatives were developed in the Operable Unit I FS, EPA identified specific action elements which were part of at least one or more of the alternatives. These action elements are listed in Section 6 of the Operable Unit I FS. EPA then identified numerous action-specific ARARs for each of the action elements. These action-specific ARARs were evaluated in Appendix C of the Operable Unit I FS and are presented in Table 6-2 of the Operable Unit I FS.

In addition to the ARARs mentioned above, EPA also considered other Federal and State criteria, advisories, and guidance in determining the appropriate degree of cleanup for the 12th and Quivas properties. In particular, EPA considered the National Council on Radiation Protection and Measurements (NCRP) and the International Commission on Radiological Protection (ICRP) recommendation for maximum gamma radiation dose to the whole body. This dose, 100 mrem/yr, is for chronic exposure to the general public, excluding natural background and medical radiation. This recommended level is more protective than the level established by the NRC in its regulations (10 CFR Part 20), and will be used in evaluating exposures to those working on the site but who are not associated with remedial cleanup of the 12th and Quivas properties.

SARA Section 121(d)(3) codifies EPA's offsite disposal policy, which requires that offsite disposal of any hazardous substances, pollutants, or contaminants from a Superfund site take place only at a facility that is in compliance with applicable Federal law and all applicable State public health and environmental requirements. Furthermore, the unit to which these

Table 5
POTENTIAL CONTAMINANT-SPECIFIC ARAR'S
OPERABLE UNIT 1, DENVER RADIUM SITE

Regulatory Agency	Type of Contaminant	Standard, Requirement, Criteria, or Limitation	Comments
FEDERAL			
U.S. EPA-40 CFR 192, Subpart B-Standards	Radium-226 Concentration	5 pCi/g above background within 15 cm of the surface measured over a 100-m^2 area 15 pCi/g above background within subsequent 15 cm layers measured over a 100-m^2 area	Standards for cleanup of open lands or buildings; concentration of radium-226 in land, averaged over any area of 100 square meters. Point of compliance is at any contaminated area greater than 100 m^2. However, during cleanup all contaminated area would be remediated.
	Gamma radiation[a]	20 μR/hr above background	Relevant and appropriate to indoor gamma radiation. Point of compliance is inside any site building.
	Radon Decay Product Concentration	0.02 WL annual average 0.03 WL maximum	Relevant and appropriate to indoor radon. Point of compliance is inside any site building.
Nuclear Regulatory Commission (NRC) 10 CFR 20	Uranium-natural Airborne Concentrations	5 pCi/m^3, Unrestricted area 100 pCi/m^3, Restricted area	Point of compliance is any location within site.
	Thorium-230 Airborne Concentrations	3 pCi/m^3 Unrestricted area 30 pCi/m^3, Restricted area	Point of compliance is any location within site.
	Radium-226 Airborne Concentrations	3 pCi/m^3 Unrestricted area 30 pCi/m^3, Restricted area	Point of compliance is any location within site.
	Gamma radiation[a]	5 rem/yr, (5,000 mrem/yr) Restricted area 500 mrem/yr, Unrestricted area	Point of compliance is any location within site; site would be unrestricted for remediation workers.

[a]Relevant and appropriate standard but not as protective as Other Guidance; see Table 4-2.

[b]An unrestricted area is regarded as any place around a waste consolidation/storage area facility where access is not controlled.

[c]A restricted area is regarded as any place around a waste consolidation/storage area where access is controlled.

wastes are transported must not be releasing any hazardous waste or constituent to ground water, surface water, or soil, and any such releases from other units at the facility must be controlled by an approved corrective action program. It is incumbent upon the State of Colorado, as part of its CERCLA requirements, to assure the availability of a disposal facility which is in compliance with EPA's offsite disposal policy.

Cost-effectiveness and Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable: Alternative 9, Onsite Temporary Containment (Capping), Offsite Permanent Disposal is a cost-effective remedial action alternative which effectively mitigates and minimizes threats to and provides adequate protection of public health and the environment. The results of this alternative cannot be achieved by the methods envisioned in the two alternatives which were less costly, Alternatives 1 and 2. Although the temporary building- or land-storage facilities envisioned in Alternatives 7, 8, and 10 may be slightly more protective than Alternative 9, they are not as implementable and EPA believes a cap over the open areas of contamination and the temporary storage facility for the contaminated material which is present under the buildings will provide the necessary short-term protection for the 12th and Quivas properties.

The selected remedy will address the principal threat at the 12th and Quivas properties. However, the selected remedy does not satisfy the statutory preference for treatment as a principal element. As part of the selection of remedy process, EPA evaluated permanent solutions to the hazards associated with the specific substances present on the 12th and Quivas properties. However, since the hazardous substance associated with the 12th and Quivas properties is a radioactive element, the number of treatment technologies which may successfully reduce the mobility, toxicity, and volume of the hazardous substance is extremely limited. The characteristic of spontaneously emitting energy and subatomic particles is a property inherent to each atom of a radioactive element and which cannot be altered or destroyed by any chemical or physical treatment known today. Most treatment and resource recovery technologies concentrate the radioactive elements present in the waste, increasing toxicity without significantly reducing volume or mobility. These treatment and resource recovery technologies will also leave a waste product which is still radioactive. Nonetheless, EPA considered several treatment and resource recovery technologies in the technology scoping and screening phase and even the initial alternative screening stage of the Operable Unit I FS. However, no technology was found which would result in a permanent and significant decrease in the toxicity, mobility, and volume of the hazardous substance, radium, which is present on the 12th and Quivas properties.

Future Actions

The future remedial activities that are required to complete remedial action at the 12th and Quivas properties are:

(1) Design remedial action.

(2) Enter in to State Superfund Contract with State of Colorado.

(3) Conduct temporary remedial action for contamination present on 12th and Quivas properties.

(4) Select and, if necessary, design and construct permanent disposal facility. (This activity is to be conducted by State of Colorado.)

(5) Remove contaminated material from the 12th and Quivas properties and transport to permanent disposal facility.

(6) Confirm that the 12th and Quivas properties have been decontaminated to conform with the requirements of ARARs and can be made available for unrestricted use.

Schedule

Dates for completing key milestones leading to remedial action at the 12th and Quivas properties are highlighted below:

(1) Complete design of remedial action by September 30, 1988.

(2) Finalize State Superfund Contract with State of Colorado by September 30, 1988.

(3) Initiate remedial action no later than during first quarter fiscal year 1989.